SERDP
Strategic Environmental Research and Development Program

Detection and Classification of Buried Metallic Objects

Unexploded Ordnance
UX-1225

Background:

Building on an earlier SERDP SEED project (UX-1174), this project sought to design an optimum active electromagnetic (EM) system that can extract, from the measurements, the best possible estimates of the location, depth, size, shape and metal content of a buried metallic object in the presence of the interfering response of non-unexploded ordnance (UXO) metallic objects. Discrimination can be achieved through selective filtering of the response inherent to the system design followed by post acquisition data processing. The parameters of the object are obtained by an inversion of the measurements to establish the principal EM moments of the detected object. These are never determined perfectly because of a fundamental non-uniqueness in the solutions (the response of the target) to the governing diffusion equation. Limitations introduced by depth of the target, the response of the ground, and the presence of other non-UXO metallic objects combine with constraints of weight and power considerations to restrict what is achievable. An optimum system is bounded by these theoretical and practical considerations and, in the end, represents a compromise that detects, discriminates, and classifies to an agreed upon specification.

Objective:

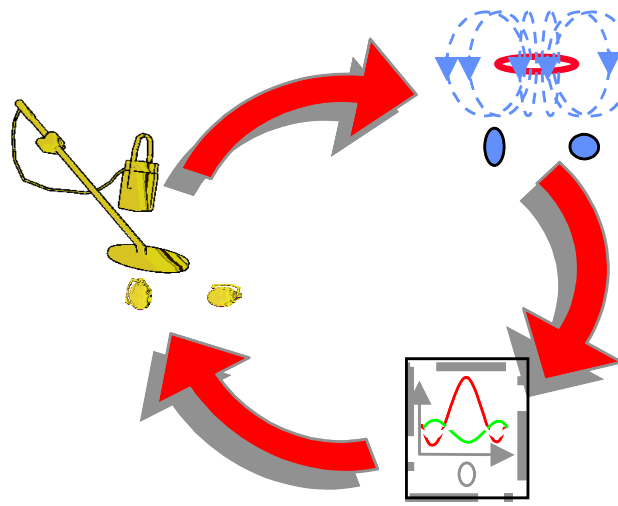
The project performed basic research to develop a systematic approach for the design and fabrication of an optimum active EM system based on the methodology employed in the minerals exploration industry in the search for metallic ore bodies. The intent of the optimum system, bounded by practical and theoretical limitations, is to detect, discriminate, and classify buried ordnance.

Process/Technology Description:

The design of the optimum system was achieved through the integration of: (1) a comprehensive set of simulators for determining the response of arbitrary conducting, permeable bodies; (2) a simple algorithm that determines the principal moments of a target and computes the band-limited frequency spectrum or the transient decay of the response in the principal axis directions; and (3) a technical assessment of the current systems and the optimal system, with particular emphasis on the ambient and geological noise levels. The project culminated in design parameters for the construction of an optimal prototype.

Results:

The researchers have developed an active EM system that not only detects metallic objects but also is optimized to determine their size, shape, orientation, shell thickness, and metal content under real-world conditions. They employed a systematic approach, focusing on the key sensor issues of transmitter-receiver configuration, while optimizing bandwidth, signal-to-noise ratio, and transmitter power. The resulting sensor is a radically different design from current commercial instruments. This prototype now provides promising UXO detection and discrimination capability, which will result in substantially reduced field survey costs. The project has successfully transitioned the EM-based tools to the Environmental Security Technology Certification Program (ESTCP) for full-scale demonstration and validation under ESTCP project UX-0437.



Example of the Electromagnetic Sensing System

Benefits/Implications:

This project has developed an active EM system that is of radically different design than currently available sensors. From single location measurements, it can extract the best possible estimates of the location, size, shape, and metal content of a buried metallic object in the presence of an interfering response. The overall objective was to design a survey instrument that provides the best detection and discrimination of UXO with the lowest field survey cost. (Project Completed – 2004)

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